

Received November 9, 1769.

IV. *Experiments in Support of the Uses ascribed to Ganglions of the Nerves, in Philosophical Transactions, Vol. LIV. and Vol. LVII. by James Johnstone, M. D.*

Read at R. S.
Feb. 1, 1770.

HAVING before had the honour of having my thoughts on the uses of ganglions, which hitherto had remained an unsolved problem, read to the Royal Society; it was observed that a principal, and indeed almost the only objection of any weight, to which the doctrine was liable, arose from the indisputable fact, That each of the nerves arising from the spinal marrow had a ganglion.

The concurrence of argument in favour of the general doctrine persuaded me, that these ganglions of the spinal nerves respected exclusively the filaments which are detached from the spinal nerves to the great sympathetic nerves, a new contexture taking place in those ganglions capable of intercepting the usual powers of volition: and that those filaments distributed to the voluntary muscles, underwent no such change from their usual rectilineal and parallel direction

direction and arrangement. I was not, till lately, capable of proving this by experiments, with which I beg leave once more to trouble the Royal Society, as they much support the new uses assigned to ganglions, in the Essay published in the LIVth volume of Philosophical Transactions, and defended in another paper published in the Philosophical Transactions, volume LVIIth, for 1767, and open a new field of anatomical research and philosophical speculation, not without some prospect of advancing the practice of medicine in nervous diseases, with the knowledge of the nervous system.

But before I proceed to relate the experiments which follow, I beg leave to premise what is allowed by all physiologists, that when any nerve is irritated, the muscle it goes to, or, if it has a large nerve, or bundle of nerves, all the muscles supplied from thence, are by that irritation violently convulsed.

If then it shall appear, that irritation and injuries of the spinal marrow, from which the intercostal nerves, which supply the heart and intestines, truly arise, no less than the nerves distributed to the limbs, occasion violent convulsions of the limbs. and yet do not in the least affect the motions of the heart, and intestines, parts the most irritable of any in the body, as will indeed appear to any one who repeats the following experiments :

The difference will probably be accounted for by the intervention of ganglion after ganglion, constantly found betwixt the spinal marrow, and the heart and intestines. And the unprejudiced inquirer into nature will probably be led to ascribe those uses to ganglions, which I have done.

Experiment

Experiment 1st. On the 4th of March, 1767, a kitten a week old, had its head cut off betwixt the first and second vertibre of the neck; the thorax was opened with all expedition, and the heart laid bare to view and observed for some time, that any difference might be easier and more certainly noticed. After the animal ceased to move its limbs, I touched the spinal marrow with a probe, immediately the extremities of the animal were all strongly convulsed; but the heart alone seemed unaffected, and continued to move without acceleration, or any degree of alteration whatever.

Betwixt this time, and the 10th of April, I repeated the same experiment upon half a dozen kittens still younger than the first; upon opening the thorax, the heart beat near 70 strokes in a minute.

When the heart beat only 40 in a minute, or thereabouts, I began gently to touch the spinal marrow with the point of a probe, and the limbs were immediately convulsed, but the heart not in the least affected.

I slit open both the ventricles of the heart, so as to let out all the blood they contained; and instantly the heart ceased to beat (though its pulsation continues otherwise very long in animals so young): but the auricles which were not opened, and therefore were still stimulated with the blood, beat on.

In this situation, in several of these animals, I thrust the probe into the spinal marrow; but the heart nevertheless continued in perfect rest, and inaction; though, when its substance was pricked with the point of a knife, it might still be made to contract.

But

But though the heart and intestines remained equally unaffected in all the tryals I made by thrusting the probe into the spinal marrow, the following contractions occasioned by it deserve particular enumeration.

All the limbs were violently convulsed.

The muscles of the neck were convulsed, and the spine bent as in the opisthotonos.

The intercostal muscles were all contracted; and their natural action (that of drawing all the ribs nearer each other and the summit of the thorax) rendered matter of ocular demonstration.

The diaphragm was contracted strongly, notwithstanding the phrenic nerve of one side was divided in making similar experiments, by pricking and stretching it; which, by the way, constantly occasioned a convulsive contraction of the diaphragm.

Even by plunging the probe into the brain, after the head had been cut off for some minutes, the tongue, and some other muscles were made to contract.

But these experiments must be made in less than a quarter of an hour after decapitation; half an hour afterwards no such effects follow the destruction of the spinal marrow. And they succeed best by previously opening the ventricles of the heart.

Experiments similar to these have been made upon frogs, by Stuart, Baron Haller, and Dr. Whytt, and others. "When I opened" (says the last of these ingenious gentlemen) "the thorax of a frog, immediately after decollation and destroying its spinal marrow, I observed its heart beating at the rate of 60 in a minute, which is four or five pulsations
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“ less than I have generally seen the hearts of frogs
 “ make, in that time, when their thorax was opened
 “ without decollation.” — (See Whytt’s Exp. on
 living and dying animals. Eff. Ph. and Litt. vol. II.
 p. 282. — also Whytt’s Phys. Essays.)

II. “ Some young gentlemen having hanged a
 “ cat, till she was quite dead, opened the thorax,
 “ and observed only a tumultuous motion in the
 “ heart ; which soon ceased, but was renewed by
 “ pricking it with a sharp instrument ; after this,
 “ by squeezing the cardine nerves downwards, or
 “ otherwise irritating them, the heart was made to
 “ perform two or three pulsations, which it con-
 “ tinued to do for a considerable time whenever the
 “ cardine nerves were thus stimulated.” (Whytt’s
 Vital Motions, p. 355.) I relate these experiments in
 the words of their excellent author, as they were
 made with no view to the doctrine I shall endeavour
 to shew they enforce and support.

III. Animals are killed some sooner, others, espe-
 cially of the cold kind, (as frogs and tortoises, pro-
 bably on account of the largeness of their spinal
 marrow) much later, by cutting through the spinal
 marrow near its origin, by which the chief commu-
 nication of the cardine nerves with the brain is cut
 off.

The cutting through the intercostal or great sym-
 pathetic nerves, or the tying ligatures upon them,
 is also sooner or later ever fatal to the animal the ex-
 periment has been tried upon ; by finally destroying
 the motion of the heart, and instantly wonderfully
 weakening and disturbing its motions. See Vieussens.

These

These experiments seem to prove, that the Ganglions on the spinal nerves do not hinder the irritation of the spinal marrow from causing convulsions in the voluntary muscles ; and that the same Ganglions, (Exp. I.) do in all probability hinder that cause from acting (as without their intervention it must have done) upon the heart by means of its nerves chiefly arising from the spinal marrow originally ; and therefore it seems evident, and beyond a plausible conjecture, that the Ganglions on the spinal nerves relate exclusively and solely to the intercostal, or as they are otherwise called, the great sympathetic nerves, for the purposes I have formerly endeavoured to prove : and this derives farther confirmation from experiment II. as we thereby see that the heart may be made to move, as all other muscles may, by irritating or squeezing its proper nerves below their ganglions ; and that the motions of the heart cannot long continue, in warm animals especially, III. after the division of its principal nerves, which shews the dependance of the motions of the heart, ultimately, as that of all other muscles, upon its proper nerves, and their connexion with the brain.